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SUPER CONDUCTING MAGNETIC ENERGY SYSTEM WITH DVR FOR VOLTAGE QUALITY IMPROVEMENT USING PSO BASED SIMPLE ABC FRAME THEORY

S. VIJAYA LAXMI[1] & P. V. RAMANA RAO[2]

[1]*Research Scholar, University College of Engg & Tech, Acharya Nagarjuna University, Andhra Pradesh, India*

[2]*Professor & H.O.D/E.E.E, University College of Engg & Tech, Acharya Nagarjuna University, Andhra Pradesh, India*

ABSTRACT

This paper illustrates the super conducting Magnetic Energy Storage (SMES) based Dynamic voltage restorer (DVR) with Proposed Simple ABC based PSO theory. Power quality is the most important in field of Distribution system. Here PQ problems are occurs due to system connected with Non linear loads. So we need to protect consumers from PQ issues such as voltage disturbances like Sag, Swell and Sag & Swell.. A fine solution to power quality and optimization related concerned issues can be easily provided through DVR. Providing protection to consumers from grid voltage fluctuations by the Superconducting magnetic energy storage (SMES) technology based DVR. The Superconducting magnetic energy storage (SMES) technology is store the energy in magnetic field of coil without loss of any energy and is used as energy storage unit of DVR. This SMES unit improves compensation capability of DVR. This paper analyze the operation of PSO theory based DVR with SMES unit and Matlab/Simulink based models developed and performance is evaluated by simulation Results.

KEYWORDS: Dynamic Voltage Restorer (DVR), Superconducting magnetic energy storage (SMES), Power Quality Issues, Voltage Sags and Swells

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Original Article

INTRODUCTION

Now day's power systems have been witnessing tremendous changes and drastic disturbances in electric power generation and system, power Transmission, distribution of power, and end-user facilities. Huge amount of power electronic devices used in our power system network cause to power quality problems. Due to this the wave shape will affected means voltage gets disturbed from ideal waveform. The most common problems like voltage sag, swell, sag and swell, voltage interruptions and fluctuations etc. Such voltage disturbance badly affects the performance of equipments connected in the system [1].

So from these PQ problems need to protect our power system network by new technologies with custom power devices used at consumer end. The dynamic voltage restorer is one of custom power device is used to inject the voltage at PCC with help of series connected transformers against the voltage sags and swell problems. Here the DVR will get source from additional device or capacitor connected to across it, with 5his the efficiency of system will decreased.

To overcome this deficiency problem by using the SMES based DVR, with this performance of the system will be increased as it has high power rating and good efficiency is maintained with SMES device. This paper presents a super conducting magnetic energy storage unit, as the energy storage unit of DVR and DVR is

controlled by Proposed Simple ABC based PSO theory [2].

So with the aim of overcoming this deficiency SMES based DVR is used for improving the performance of power system as [7]. This paper presents a super conducting magnetic energy storage unit, as the energy storage unit of DVR and DVR is controlled by Proposed Simple ABC based PSO theory.

The paper is inspected as follows, the configuration of the DVR with Simplified ABC based PSO Method control is described, the Control technique and the voltage injection capabilities of the DVR into line with SMES is discussed. The detailed description of MATLAB Simulation model along with mitigation of voltage sag and swell conditions at different conditions are discussed. The simulation diagram was designed and its results showed using MATLAB\SIMULINK.

DVR Configuration

The figure 1 show block diagram of conventional DVR is injects a voltage in series to system. The dynamic voltage restorer is mainly used to dynamic voltage disturbance compensation in system. Here the series connection topology is more cost effective solution. Basic DVR operating principle is injecting the voltage across distribution feeder to maintain the desired voltage and wave for the load voltage. Three phase source is connected to sensitive load, if any disturbances caused in system it affects on source. So at PCC the series injected transformer is connected with DVR through LC filter [3].

The voltage disturbances at supply side is easily eliminated with DVR and also is used to inject the voltages at PCC, is called as solid state series voltage injection device. Mainly DVR is used to maintain good profile of system voltage, means compensate the whatever faults appears at system these are voltage sags, swells, voltage sag and swells or multiple voltage sags and swells.

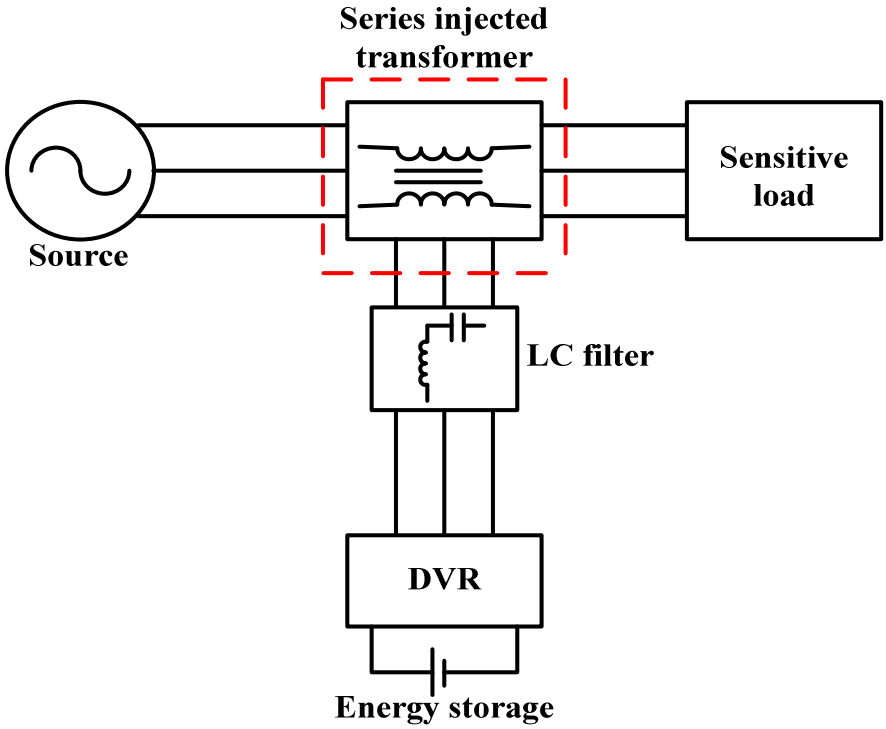

Figure 1: Block Diagram of Conventional DVR

Simplified ABC Frame Based PSO Control Theory

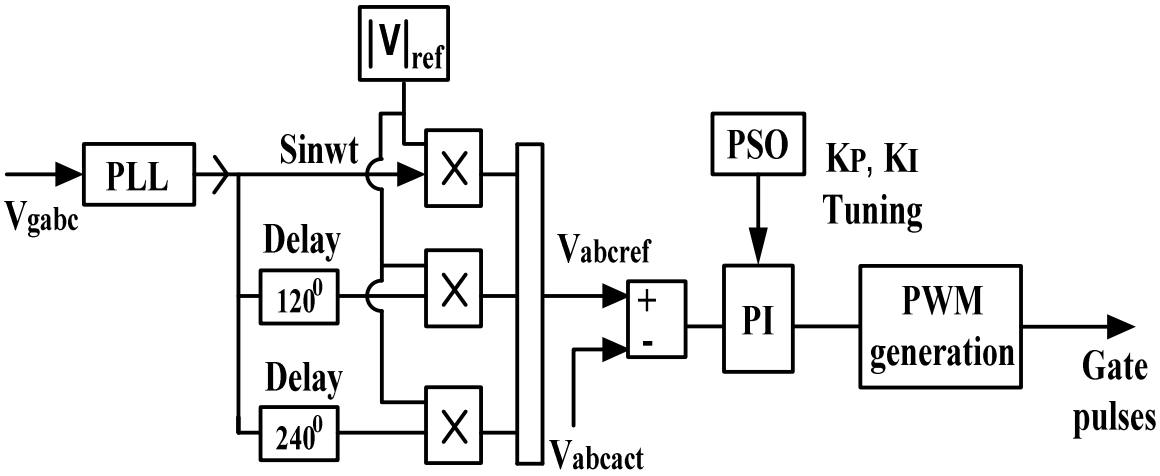

Figure 2: Simplified 'ABC' Frame Based PSO Control Theory

The figure 2 shows simplified ABC frame based PSO control theory for DVR. In this theory mainly concentrated on tuned proportional and integral gain of PI controller, is automatically selected with particle swarm optimization (PSO) theory. The PLL have actual voltage is taken at PCC, PLL generates three sin w(t) components with 120 degree displacement. This PLL generated value is multiplied with V reference, then is compared with actual three phase voltage. Finally PI controller selects its gain from PSO algorithm the PWM pulses generated for switches used in DVR. PSO algorithm is very fast and effective theory compared to other [4-5].

DVR with Simplified ABC Frame Based PSO Theory

The DVR is mostly preferred because cost effective solution available in voltage disturbances compensation and power quality problems, is fast and flexible device. The control strategy used for DVR is based PSO algorithm with Simplified ABC theory, this technique develop the performance of DVR.

The figure 3 shows DVR with simplified 'ABC' frame based PSO theory block diagram. It has three phase source, source impedance, injection transformer, Voltage source converter, LC filter and control strategy. Three phase source supply the voltage to load through source impedance, with Nonlinear loads connected to system will affects with PQ problems. The PQ problems are voltage Sags swells, sag and swell is mitigated by Dynamic voltage restorer (DVR). The DVR is connected at PCC, injects voltage through series injected transformers [6-7].

The control strategy implemented for DVR is showed in figure 3 the actual source voltage V_{abc} Sensed is given to PLL which generates three phase components is multiplied by reference voltage. Final signal is sensed through PI controller, here PI controller parameters are stated by PSO algorithm. This type controller had many benefits those are it requires less processing time; size of controller is reduced and available in less cost compared to SRF controller. The controller output is given as an input to PWM Generator block. This block gives gate pulses for VSC.

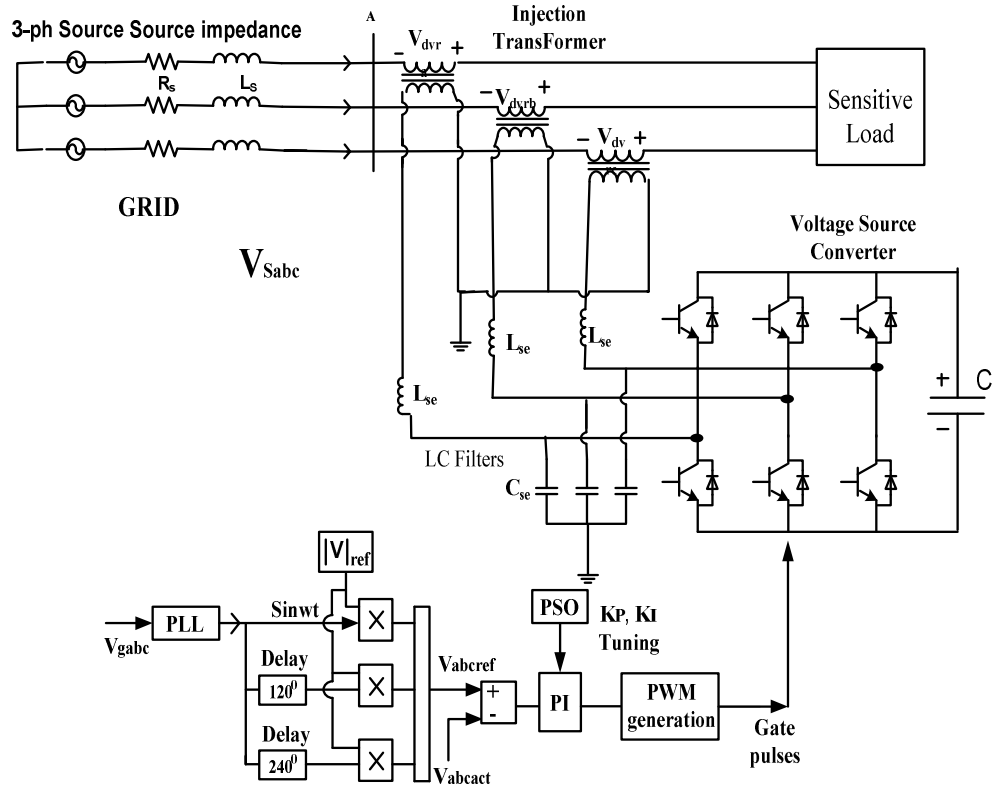

Figure 3 DVR with Simplified 'ABC' Frame Based PSO Theory

SUPERCONDUCTING MAGNETIC ENERGY STORAGE (SMES) CONFIGURATION

SMES is characterized by its high energy storage, quick response and power controllability. SMES is mainly used to supply high quality power to system. SMES is developing technology in properties of energy storage with super conducting materials. Here the energy is stored in magnetic fields. This type of unit has fast charge and discharge time this makes attractive action to mitigate problems in system. The merits are have low losses due to high superconducting characteristics. In this SMES design the super conducting coil is important element.

The figure 4 shows the block diagram of SMES is a six pulse Pwm converter with IGBT as a switching device, a inductor is a superconducting coil. A power electronic link is control the dc current flow through coil from source. The basic modes of operation explained below [8].

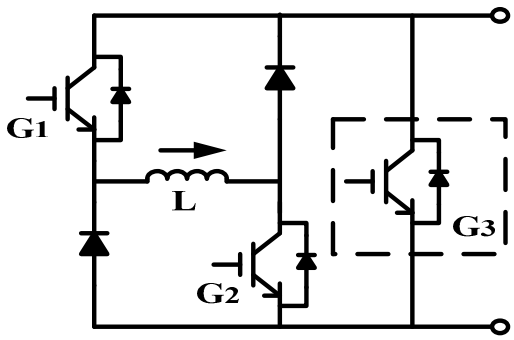

Figure 4: Block Diagram of SMES

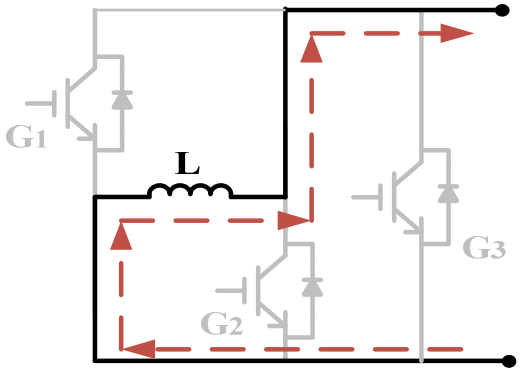

Figure 5: During Sag Discharge Condition

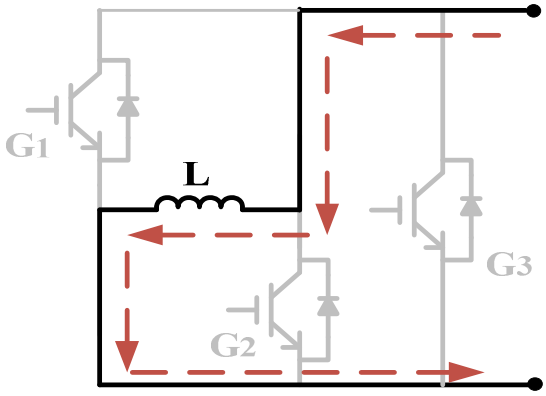

Figure 6: During Swell Charge Condition

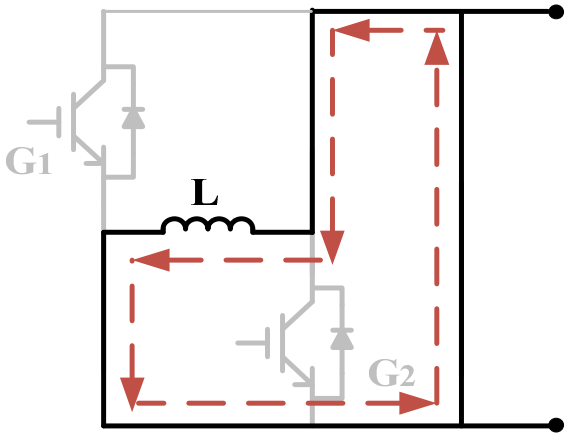

Figure 7: No Sag/No Swell Condition (No Charge/No Discharge)

Here figure 5, 6 and 7 shows the different modes of SMES operation are sag discharge, swell charge and no sag no swell condition or no charge and discharge conditions are showed. In SMES circuit the diodes both are turn on the current flow from D1 to D2 is called as sag discharge mode. Similarly current flow from D2 to D1 is called as swell charge mode or both switches 1 &2 are turn on is also called as swell charge mode. Finally no charge and discharge condition comes when switch-3 turned on it makes short circuit [8].

BLOCK DIAGRAM OF DVR WITH SIMPLIFIED 'ABC' FRAME BASED PSO THEORY CONNECTED TO SMES:

The voltage compensation capability is sensitive to load and independent of the system short circuit capacity. We need to improve the compensation capability of DVR during long duration of fault conditions. For this conditions system require energy storage unit is essential to supply the power transfer during voltage disturbances. Here super conducting magnet is used as energy storage device with DVR. The SMES based DVR performance is analyzed and its controlling action is done simplified ABC frame based PSO control theory is designed

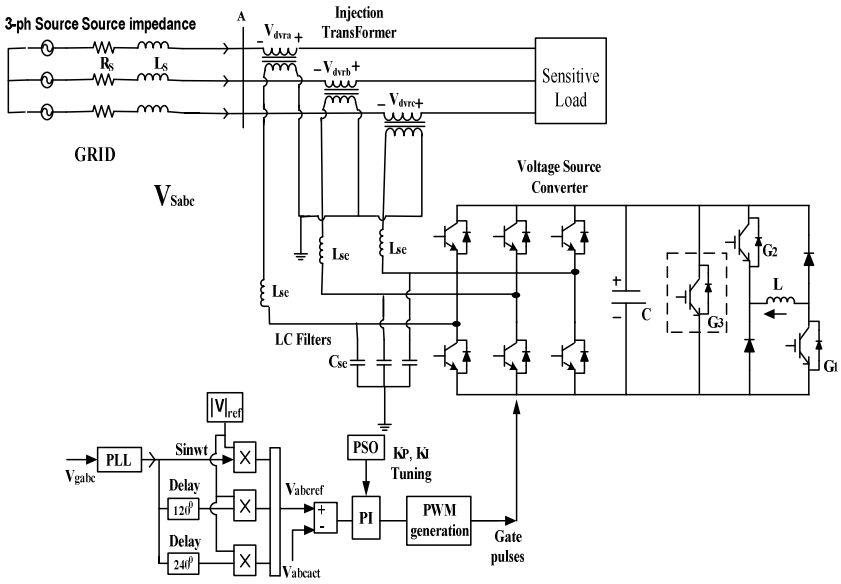

Figure 8: DVR with Simplified 'ABC' Frame Based PSO Theory Connected to SMES

The SMES is the super conducting magnetic energy system used in storage applications.

During the standby operation condition, to reduce the energy losses a bypass switch is used. Finally a transformer which provides the power system connection and co-ordination and PC operating voltage will reduce to acceptable levels. The DVR is controlled by Simplified ABC based PSO theory. The SMES with DVR is mostly used because cost effective solution [9-11].

MATLAB/SIMULATION RESULTS

SMES with DVR under Sag Condition

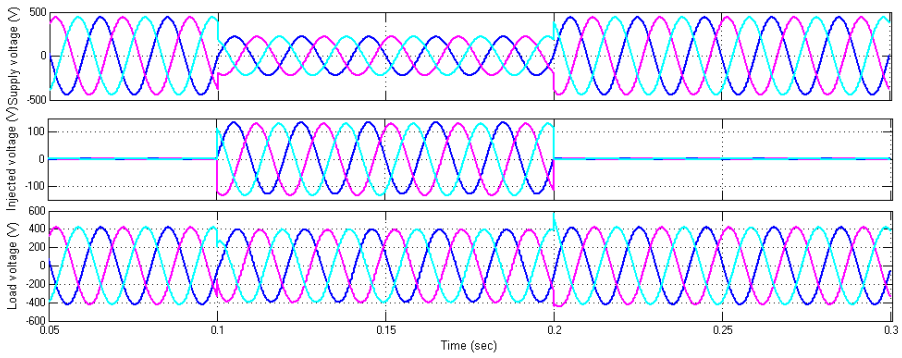

Figure 9: DVR with Sag Condition of Supply, Injected, Load Voltages

Figure 9 shows that the information about during sag condition of the system the supply voltage affected by sag this concern is mitigated by using DVR with simple 'abc' frame theory of PSO. In the supply voltage the sag occurs at the interval of 0.1 and continues up to 0.2 sec. The DVR injects the compensation voltage with supply voltage. So finally the load side voltage is maintained constant.

SMES with DVR under Swell Condition

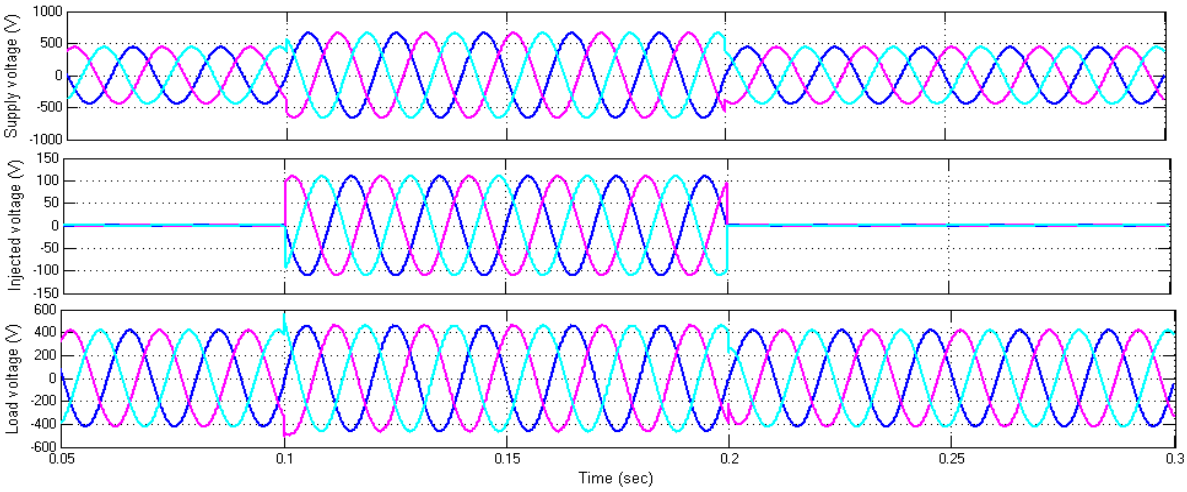

Figure 10: DVR with Swell Condition of Supply, Injected, Load Voltages

Figure 10 shows that the information about during swell condition of the system supply voltage by using DVR with simple 'ABC' frame theory of PSO. In the supply voltage the swell occurs at the interval of 0.1 and continues up to 0.2 sec. The DVR injects the compensation voltage with supply voltage. So finally the load side voltage is maintained constant.

SMES with DVR under Sag and Swell Condition

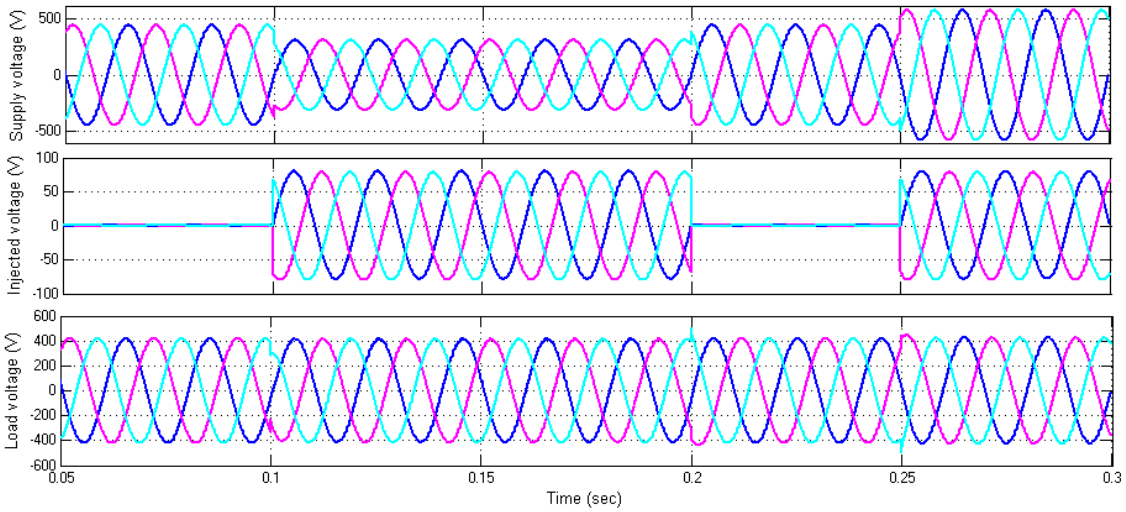

Figure 11: DVR with Sag and Swell Conditions of Supply, Injected, and Load Voltages

Figure 11 shows that the information about during sag and swell conditions of the system supply voltage by using DVR with simple 'ABC' frame theory of PSO. In the supply voltage the sag and swell occurs at the interval of 0.1 and

continues up to 0.2 sec. The DVR injects the compensation voltage with supply voltage. So finally the load side voltage is maintained constant.

SMES with DVR under Multiple Sag Condition

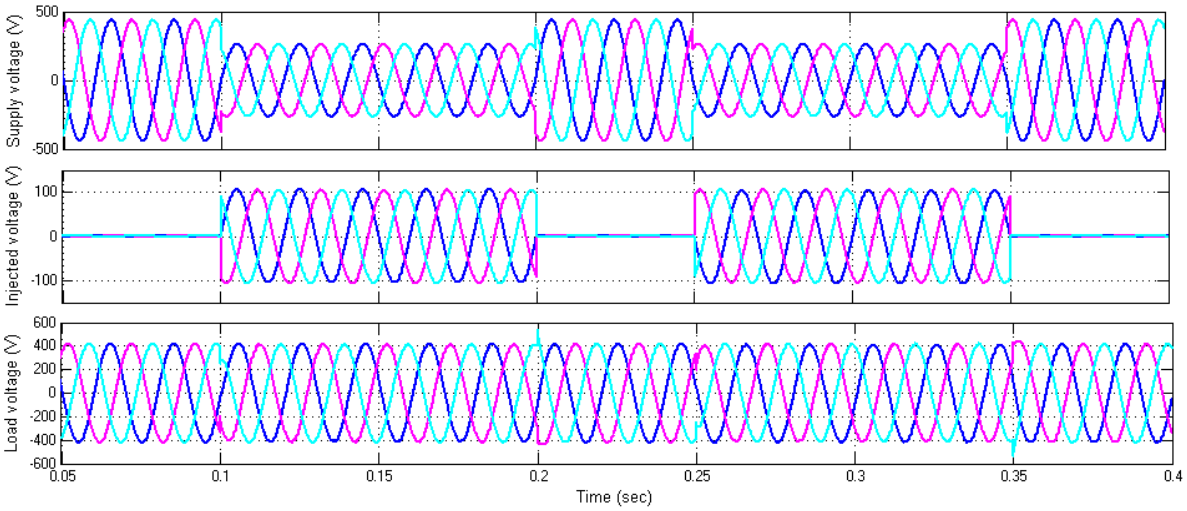

Figure 12: DVR with multi sag condition of supply, injected, and load voltages

Figure 12 shows that the information about during multi sag condition of the system supply voltage by using DVR with simple 'ABC' frame theory of PSO. In the supply voltage the multi sag occurs at the interval of 0.1 and continues up to 0.2 sec and again starts the interval of 0.25 to 0.35. The DVR injects the compensation voltage with supply voltage. So finally the load side voltage is maintained constant.

SMES with DVR under Multiple Swell Condition

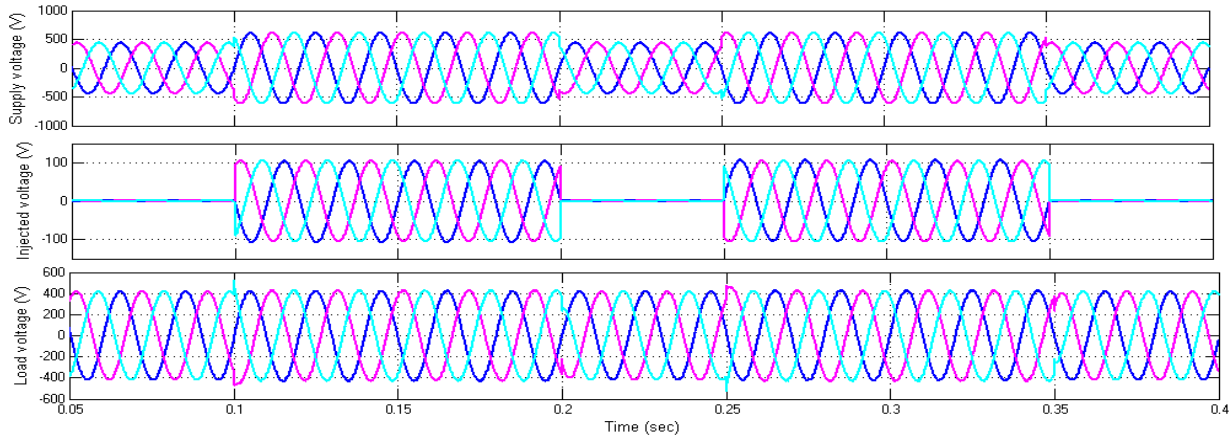

Figure 13: DVR with Multi Swell Condition of Supply, Injected, and Load Voltages

Figure 13 shows that the information about multi swell condition of the system supply voltage by using DVR with simple 'ABC' frame theory of PSO. In the supply voltage the multi swell occurs at the interval of 0.1 and continues up to 0.2 sec and again starts the interval of 0.25 to 0.35. The DVR injects the compensation voltage with supply voltage. So finally the load side voltage is maintained constant.

CONCLUSIONS

The design of the SMES module as a voltage source to compensate voltage disturbances and to improve power quality. In this paper SMES based DVR with Simplified ABC based PSO theory control strategy is presented. The simulation results prove that SMES based DVR compensate the sags, swell and sag swell conditions. The simulation shows that DVR performance is satisfactory in mitigating voltage fluctuations. Here the proposed control strategy is shows perfect control to DVR based SMES unit.

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